

An aerial photograph of the Albeni Falls Dam, a large concrete structure with multiple spillways, situated in a deep, forested valley. The water is a dark blue-green color, and the surrounding hills are covered in dense green trees. The text is overlaid in yellow on the upper portion of the image.

Albeni Falls Dam

Total Dissolved Gas Study 2003

by

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Seattle District
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Albeni Falls Total Dissolved Gas Study

- Introduction

- Total dissolved gas exchange study called for by USFW 2000 Biological Opinion.
- Purpose to evaluate and report to the USFW on TDG concentrations downstream of Albeni Falls dam which may occur within the full range of operations of the facility, including forced spill.
- Not a spill test.

Albeni Falls Total Dissolved Gas Study

- Objectives

- Understand TDG concentrations and processes associated with the full range of operations of Albeni Falls Dam, including forced spill.
- Determine how Albeni Falls Dam impacts TDG concentrations in the Pend Oreille River.
- Describe resulting downstream TDG pressures.
- Provide recommendations for future water quality monitoring locations.
- Provide spill pattern recommendations for reducing downstream TDG pressures.

Albeni Falls Total Dissolved Gas Study

- Study Design
 - Deployment Period
 - Sampling Array
 - Albeni Falls Dam Forebay
 - Albeni Falls Dam Powerhouse and Tailwater
 - Pend Oreille River
 - Operating Conditions
 - Pend Orielle River Flows
 - Spillway Operations and Patterns

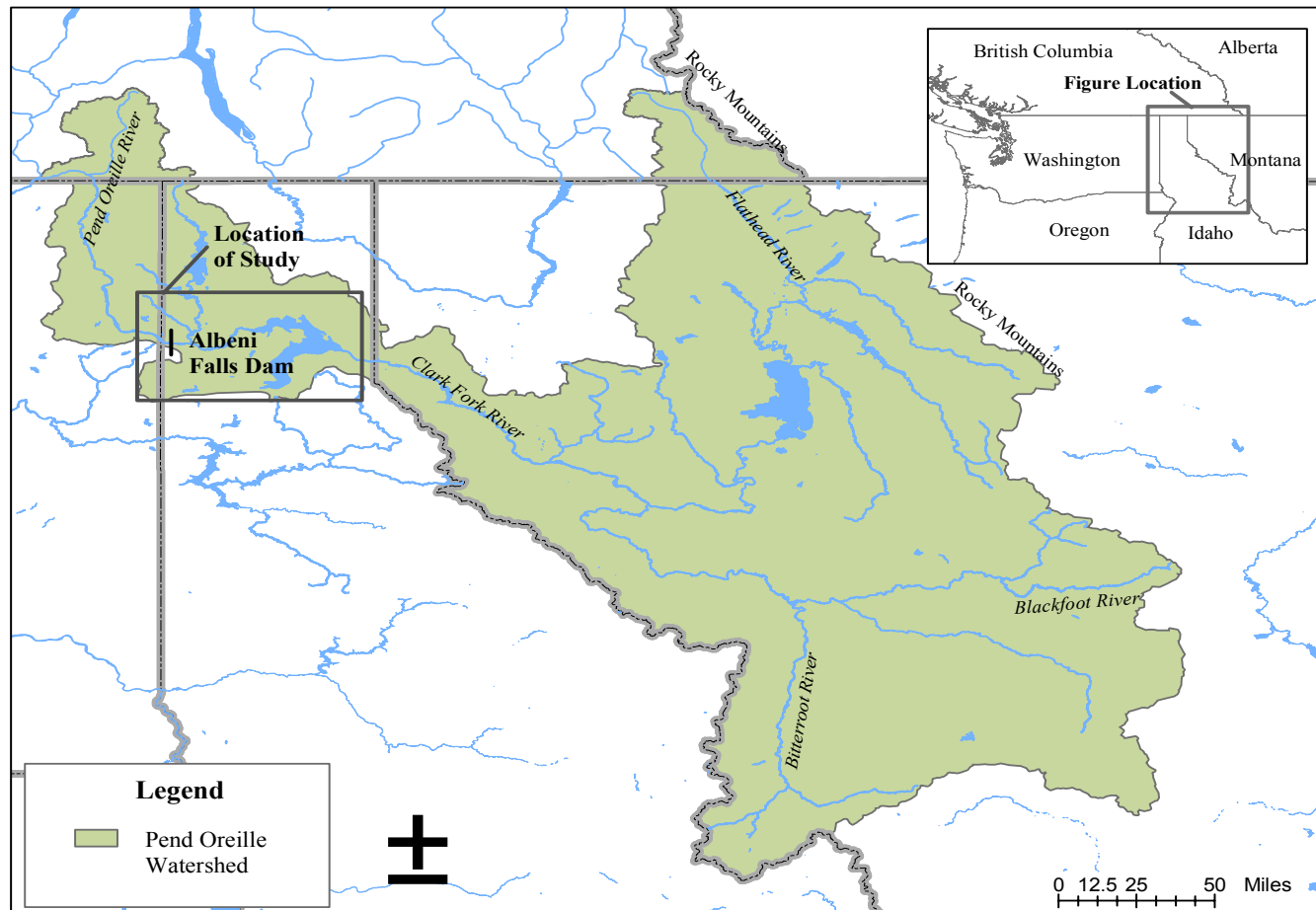


Figure 1. Location of the study area in the Pend Oreille River watershed.

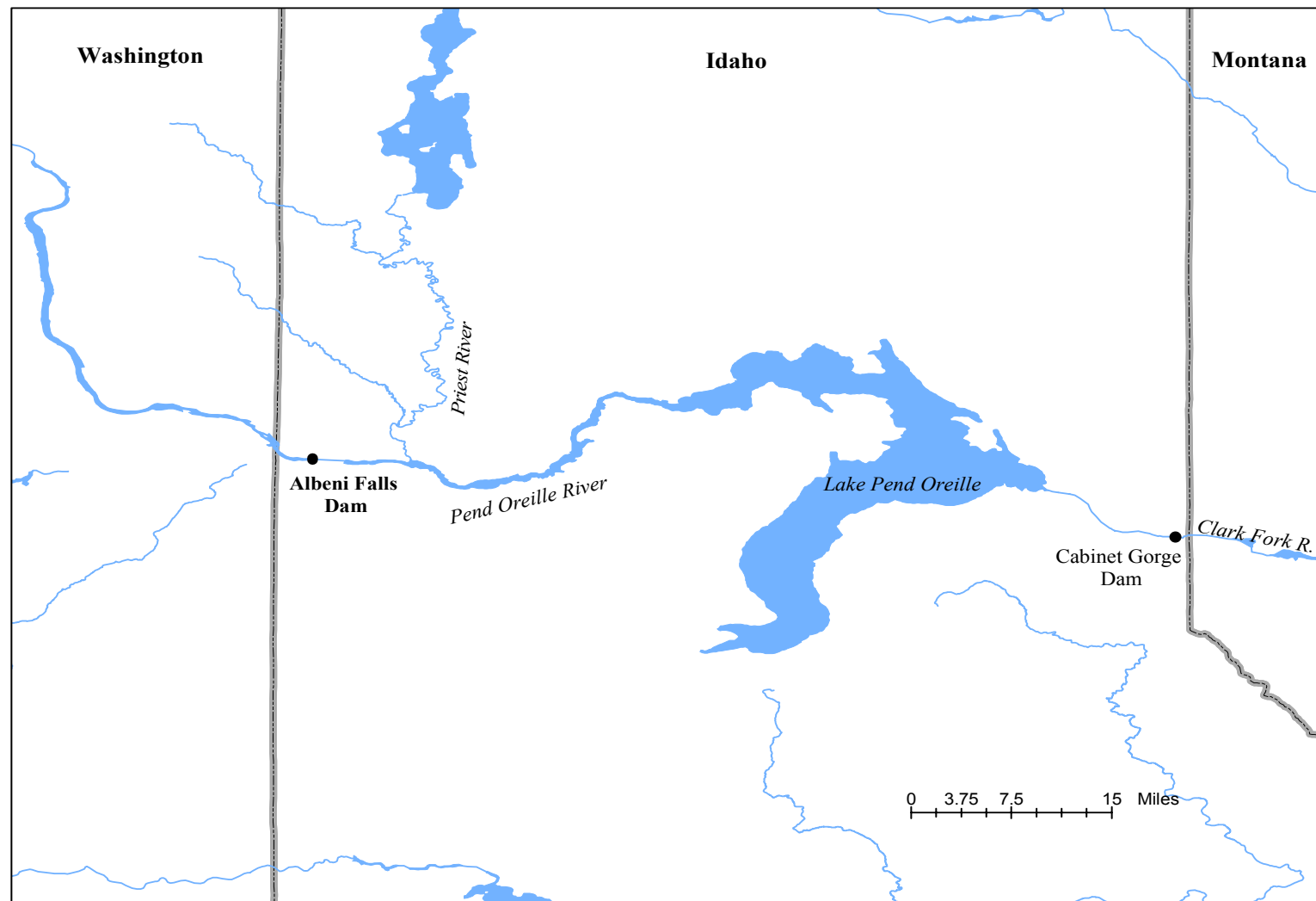


Figure 2. Location of Albeni Falls Dam.

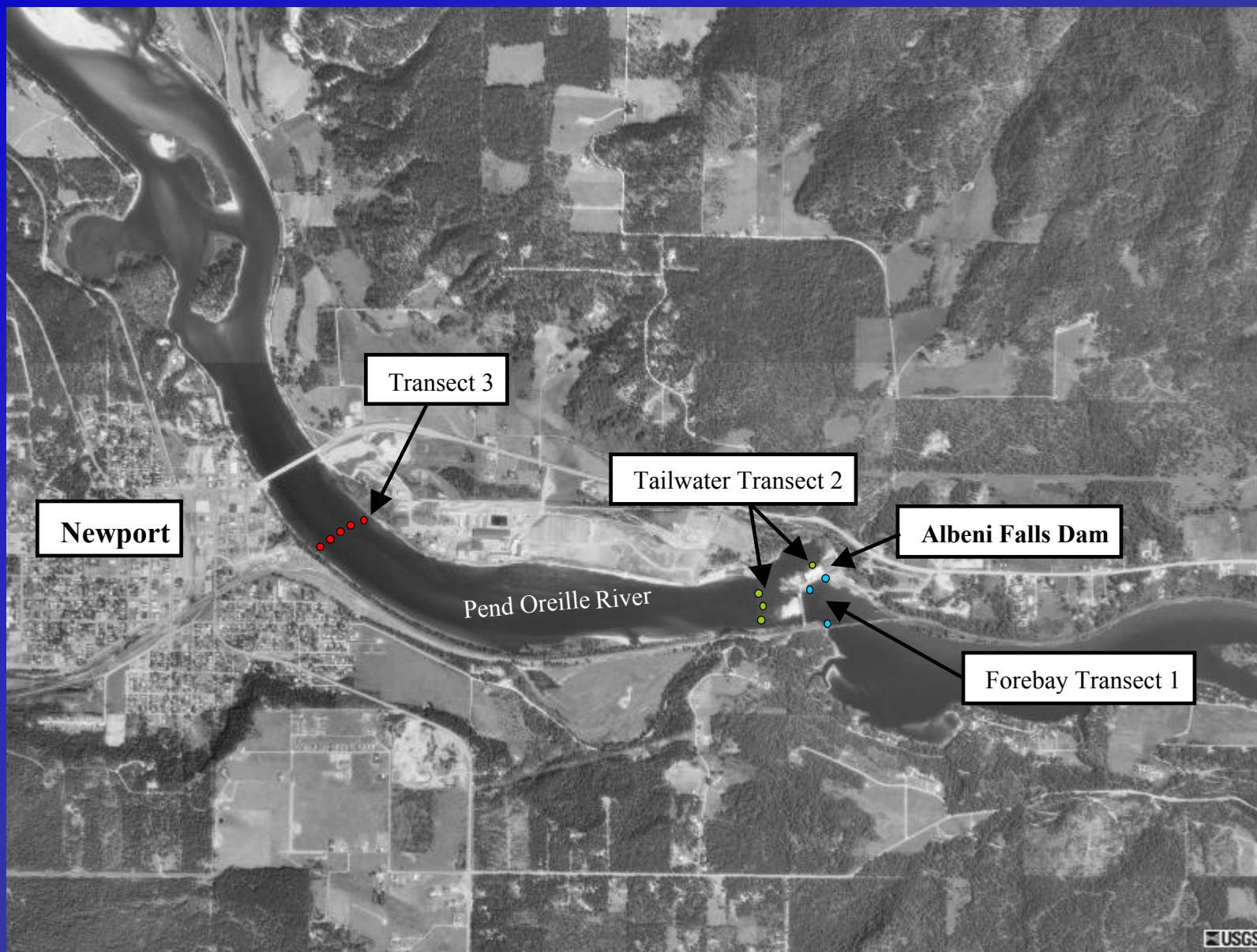


Figure 3. Total Dissolved Gas Sampling Transects and Locations in the Pend Oreille River Above and Below Albeni Falls Dam.

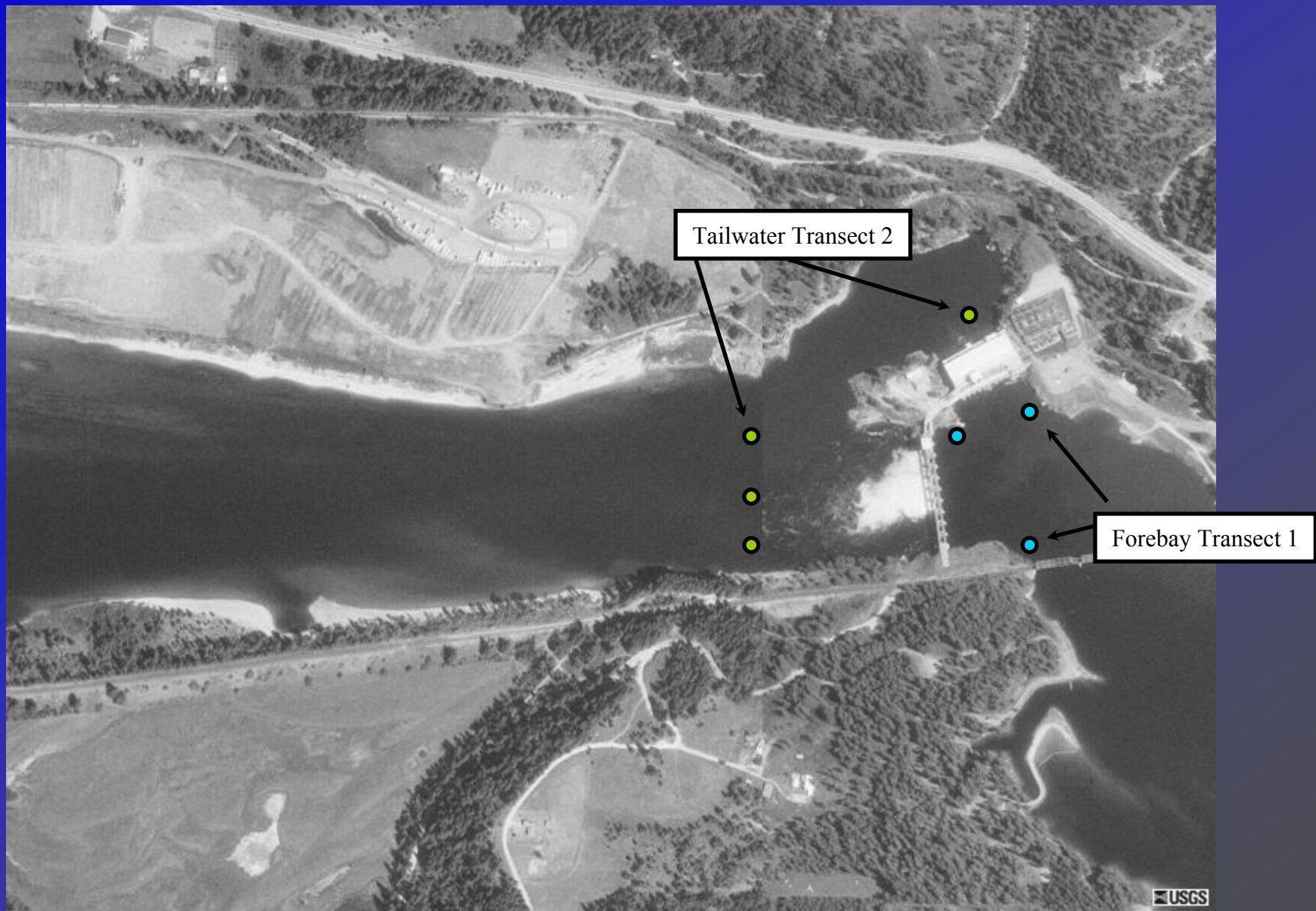


Figure 4. Total Dissolved Gas Sampling Transects and Locations in the Pend Oreille River Above and Below Albeni Falls Dam.

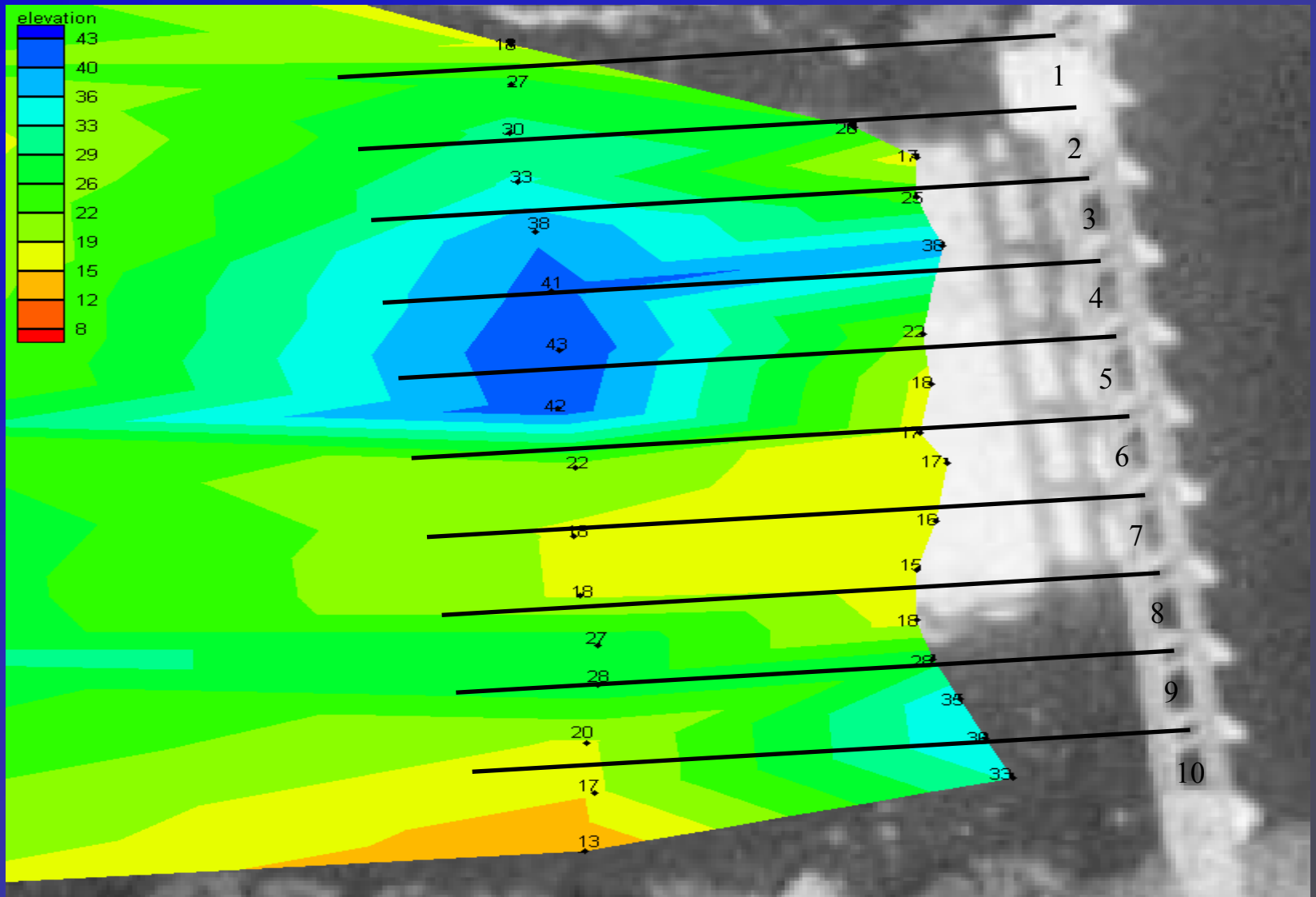


Figure 5. Depth soundings below Albeni Falls Dam on May 6, 2003.



Figure 6. Forebay sampling locations.



Figure 7. Forebay sampling locations.



Figure 8. Downstream transect number 1 sampling locations..



Figure 9. Downstream transect number 2 sampling locations..

Albeni Falls Total Dissolved Gas Study

- Water Quality Sampling Instruments
 - The Hydrolab Corp. model DS4 and minisonde 4
 - Automated wireless logging
 - Deployment
- Parameters
 - Total dissolved gas (TDG)
 - Temperature
 - Depth
- Measurements logged on 15-minute intervals
- TDG uses a semi-permeable silicone tubing for gas collection

Albeni Falls Total Dissolved Gas Study

- **Pend Oreille River Conditions**
 - Flows during 2003 study were similar to historical average flows.
 - Peak inflow of 80 kcfs on June 1 and peak outflow of 68 kcfs on June 4.
- **Albeni Falls Dam Operations**
 - Spillway flows ranged from 0 to about 48 kcfs during the study.
 - Alternative spill patterns implemented

Pend Oreille River at Albeni Falls Dam
2003 Flow vs Historical Flow (1952-1998)

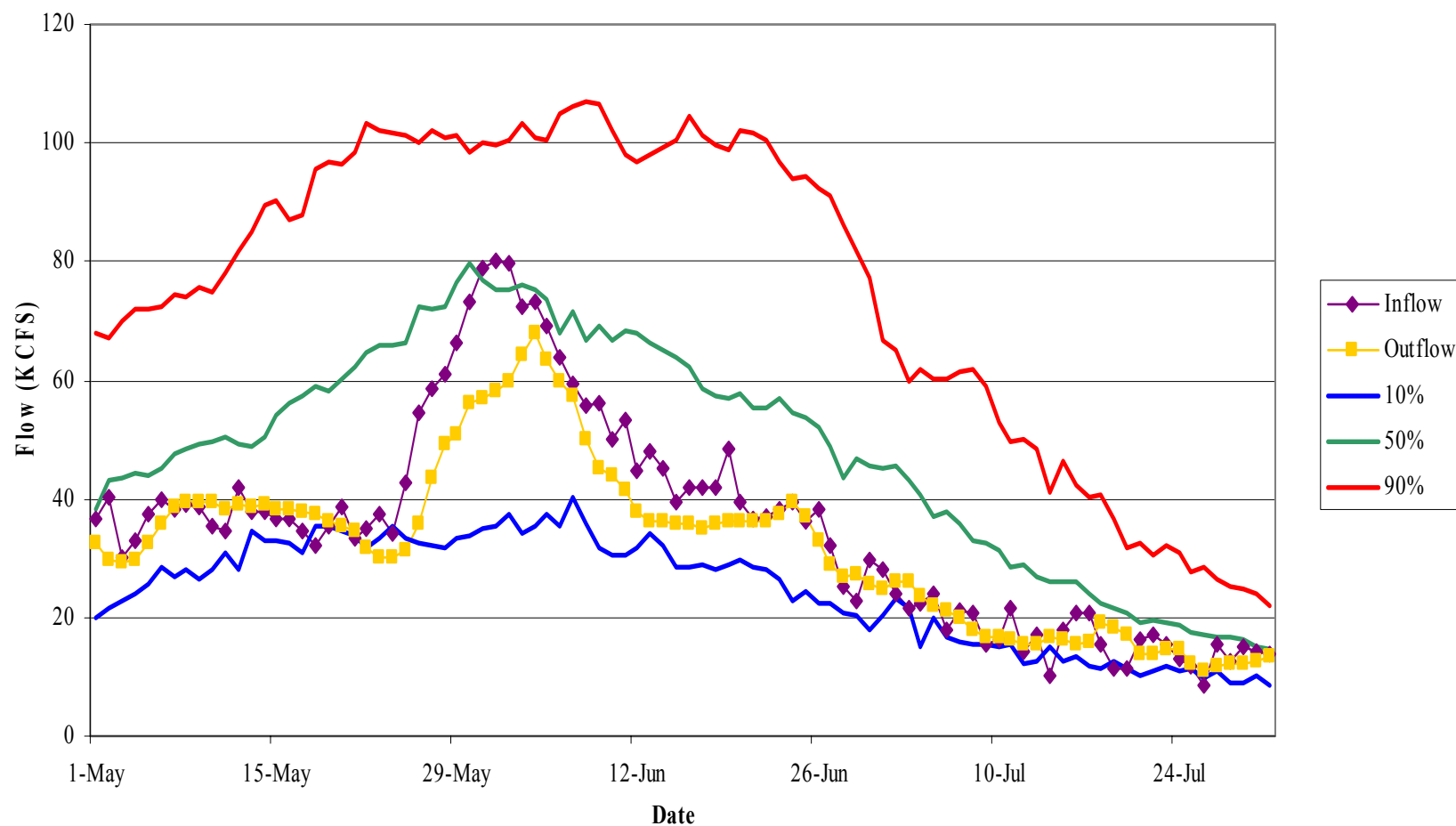
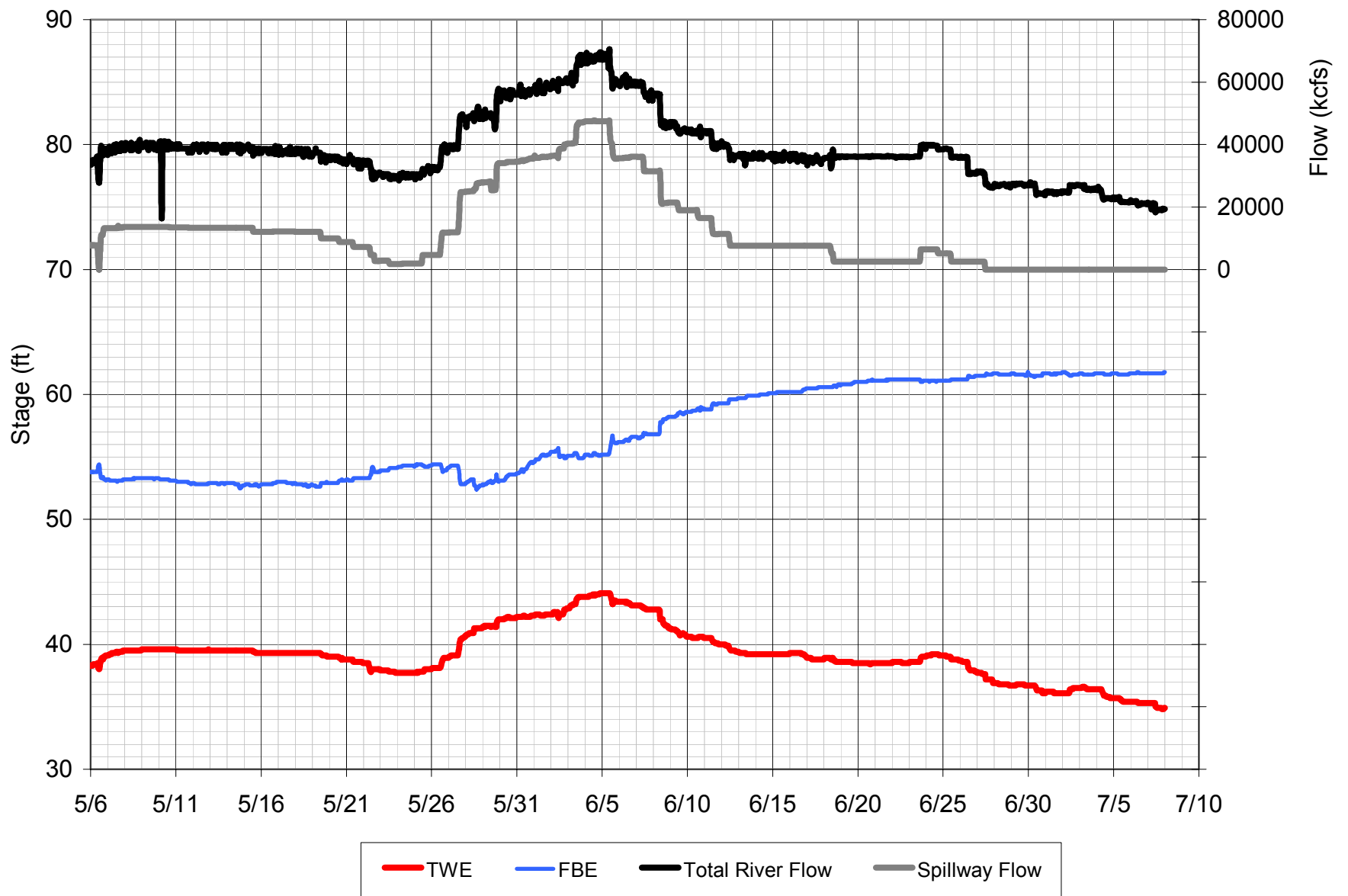


Figure 10. Pend Oreille daily 2003 flows versus historical flows at Albeni Falls Dam.

Albeni Falls TDG Exchange

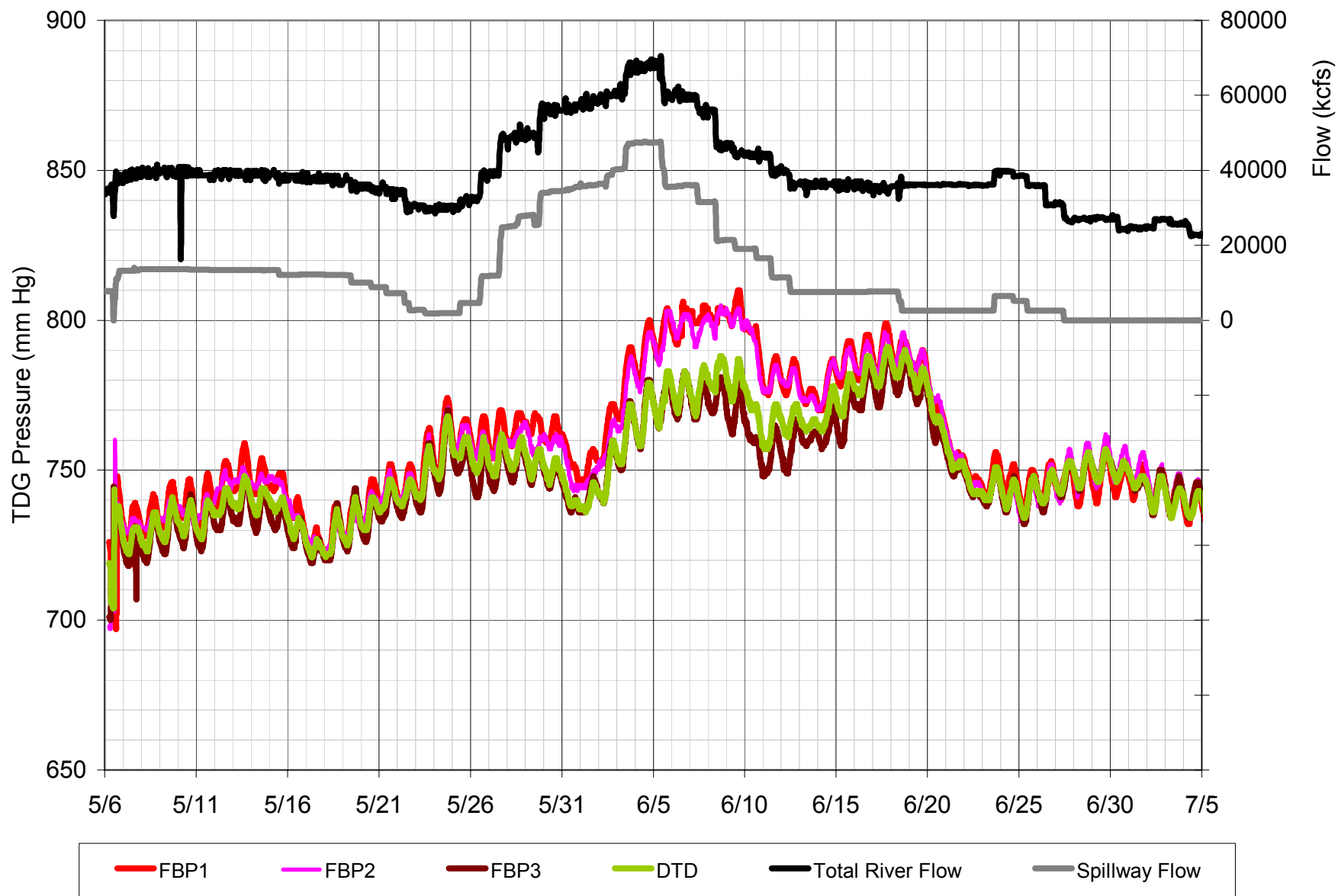
- Operating Conditions 5/6/03 – 6/27/03
 - Total River Flow
 - Spill Flow
 - Forced spill
 - Uniform/bulk spill patterns
 - Stage
 - Forebay
 - Tailwater



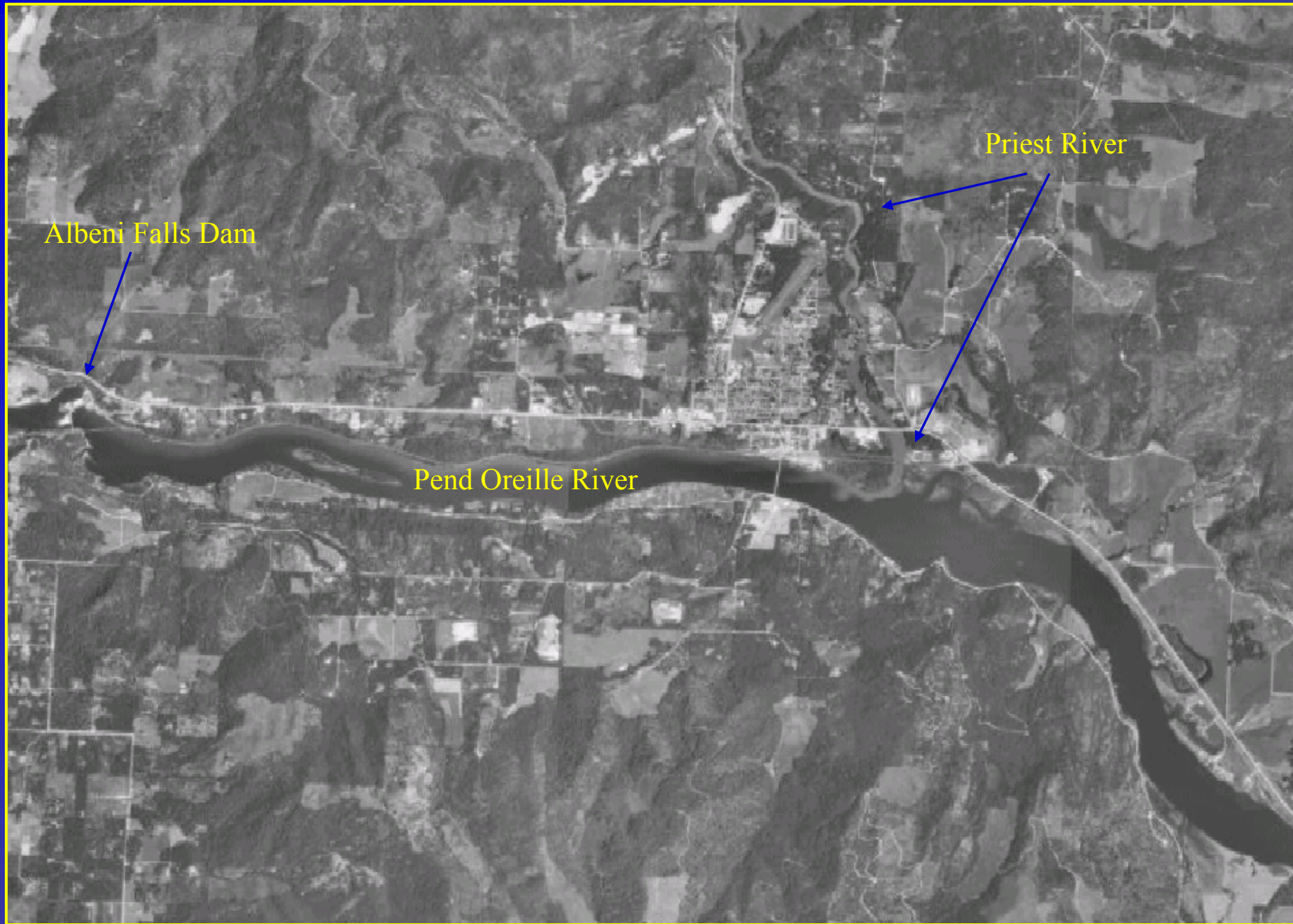
Albeni Falls project operations, 5/6/03-7/7/03

Albeni Falls TDG Exchange

- Forebay TDG levels
 - TDG near right bank biased by Priest River Inflow
 - Thermally induced daily TP cycle
 - Forebay TDG level range
 - 101 to 116.4 %
 - Lateral gradients as high as 3-4%
 - Powerhouse releases generally do not change TDG pressures



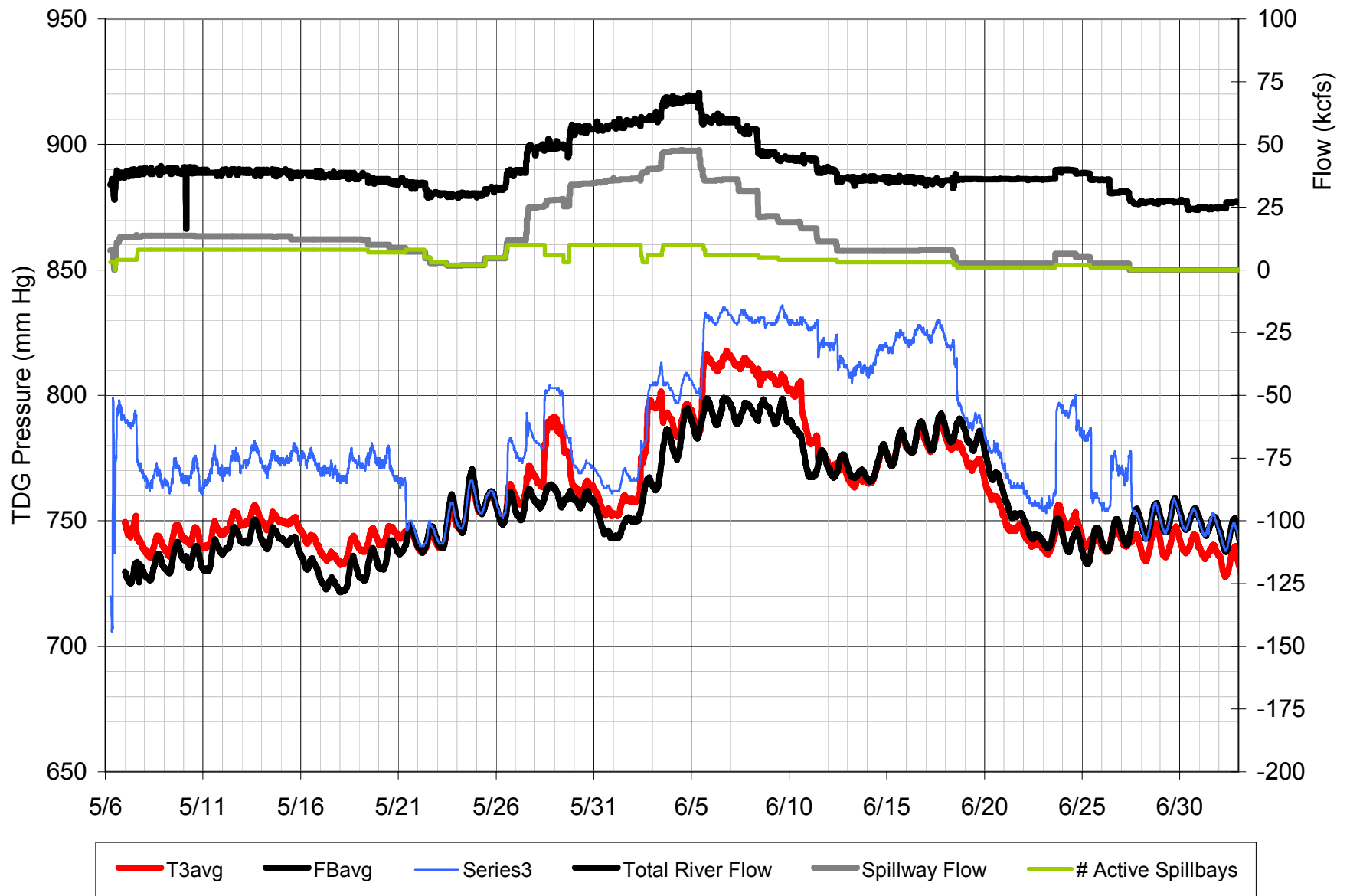
Forebay TDG pressure and Albeni Falls Dam Operations, 2003

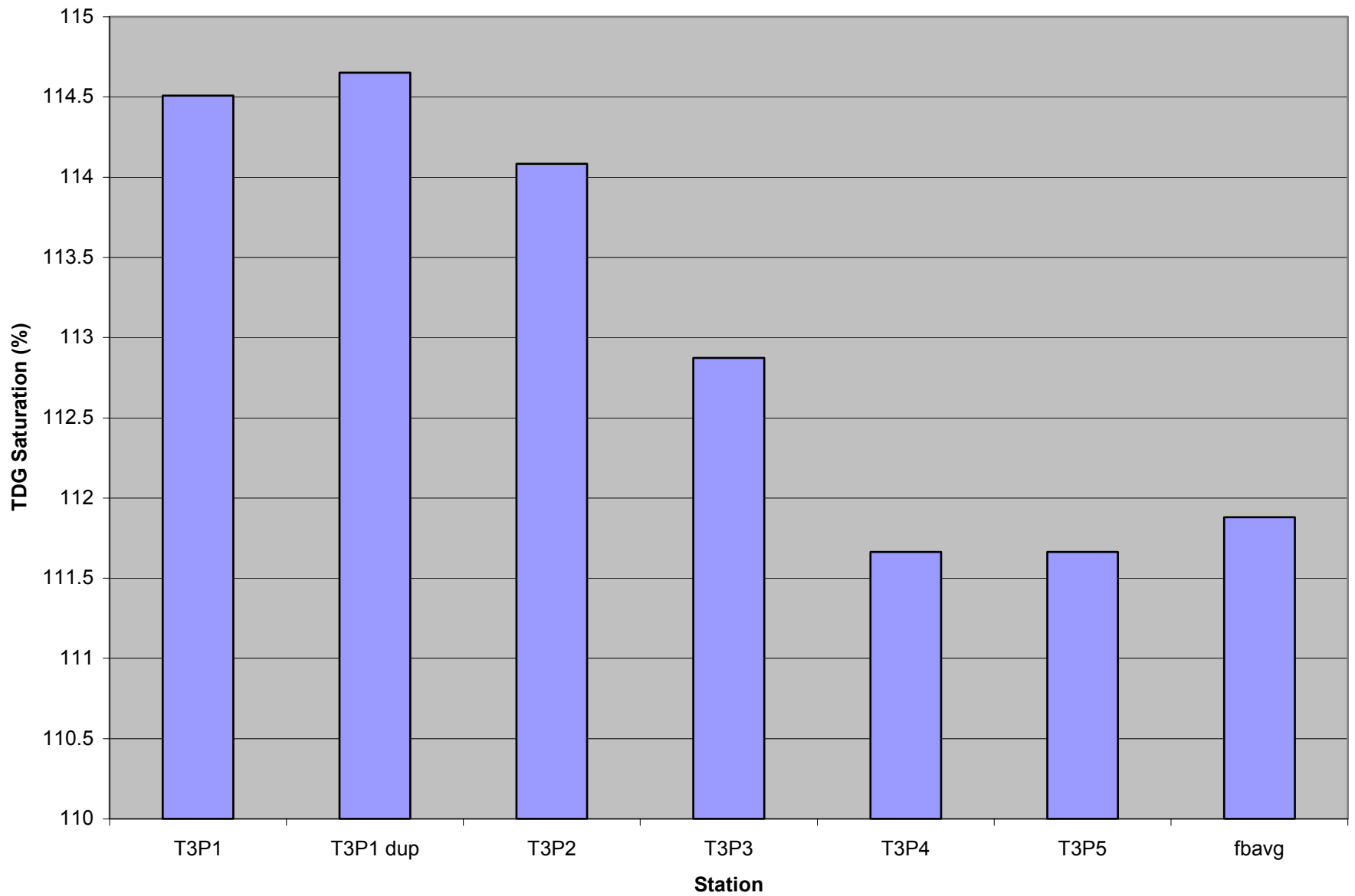


Albeni Falls and Priest River Aerial Photo

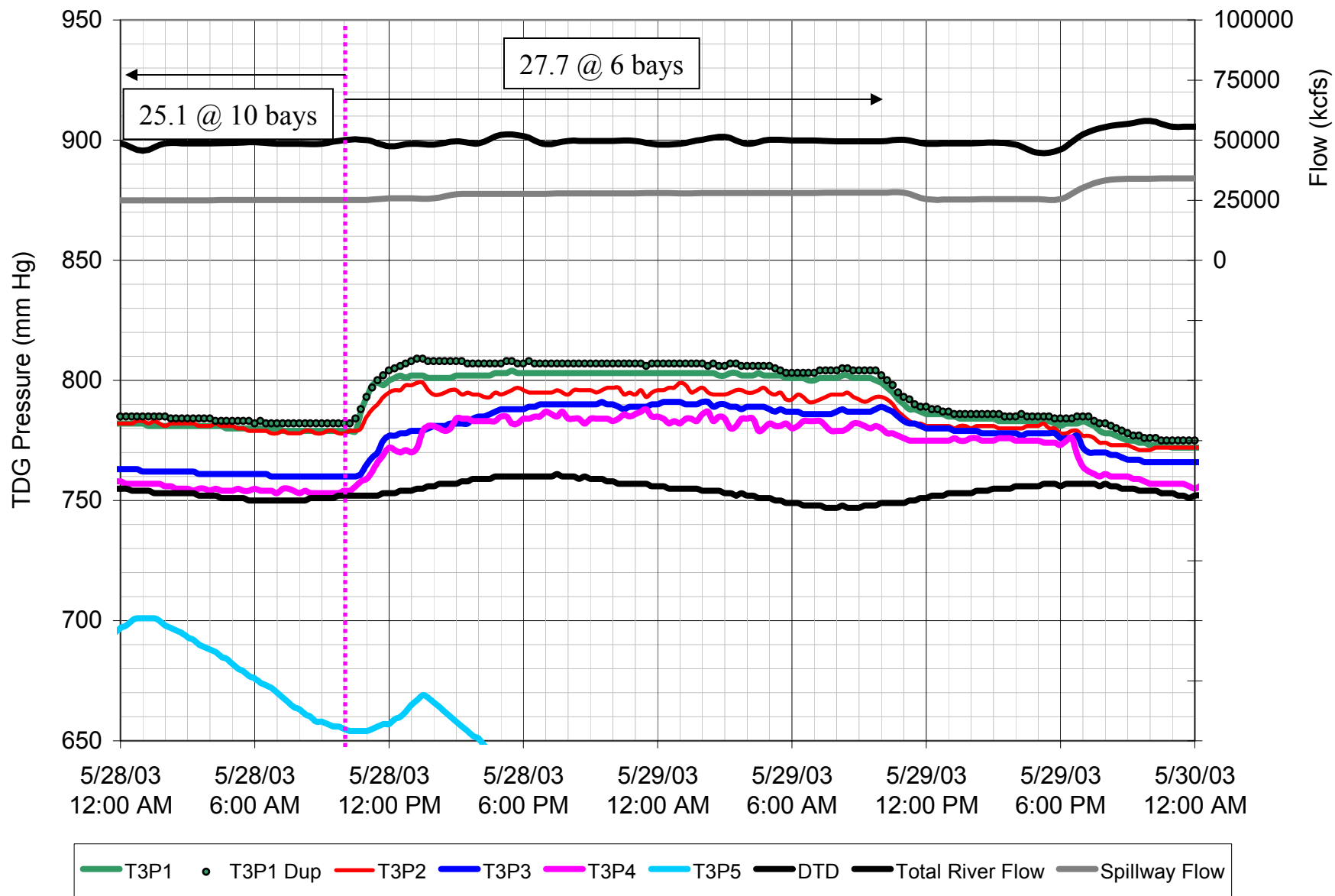
Albeni Falls TDG Exchange

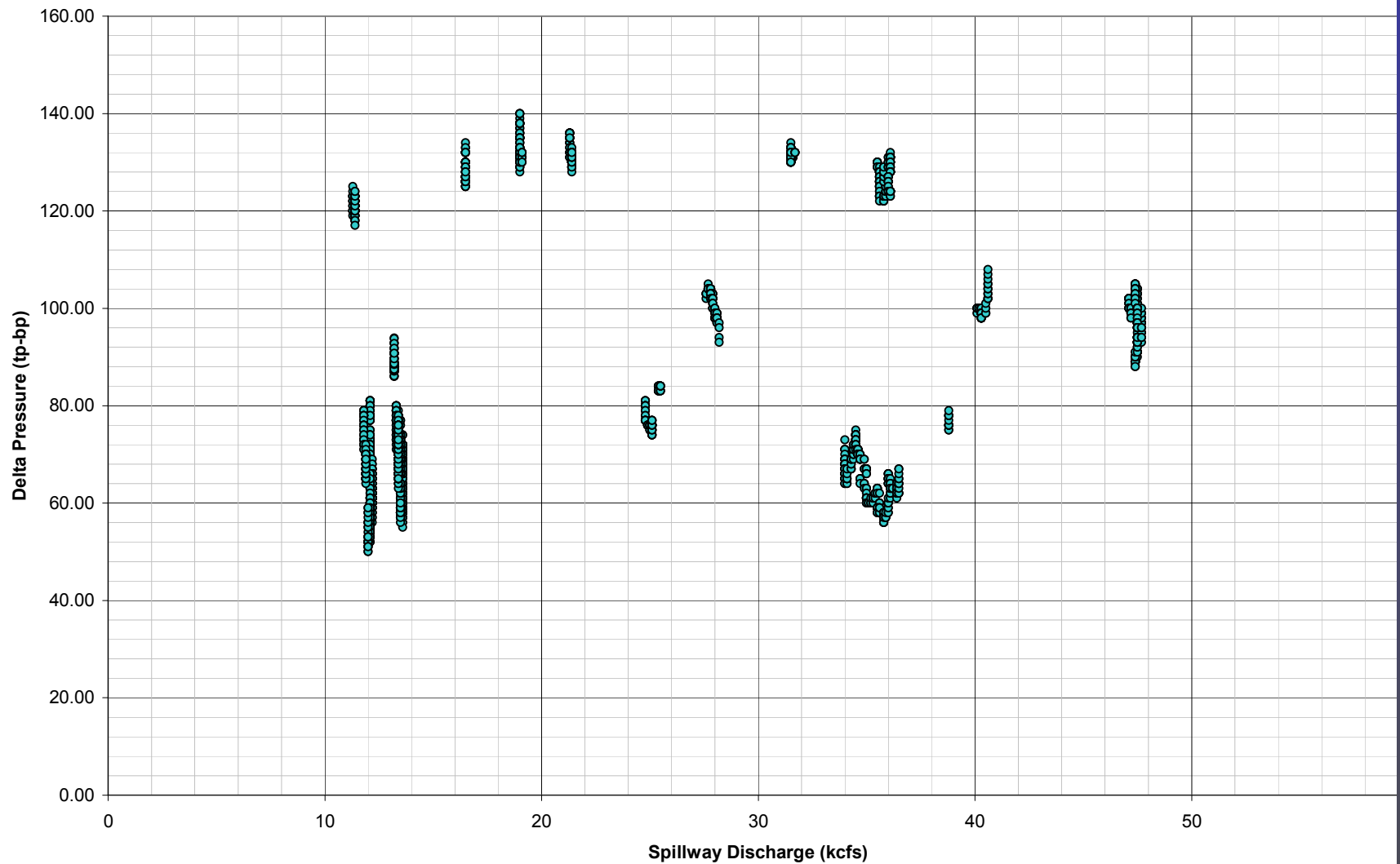
- Spillway releases can result in elevated TDG pressures in Pend Oreille River
 - Increase in cross sectional TDG saturation averaged 0.8%
 - Bulk spill pattern generally yields higher rates of TDG exchange
 - Some spill events retained forebay TDG levels
 - Limited amounts of entrained air
 - Spill TDG levels impacted by
 - Spill pattern
 - Tailwater channel depth
 - Head (FBE-TWE)
 - Forebay TDG
 - Gate Submergence



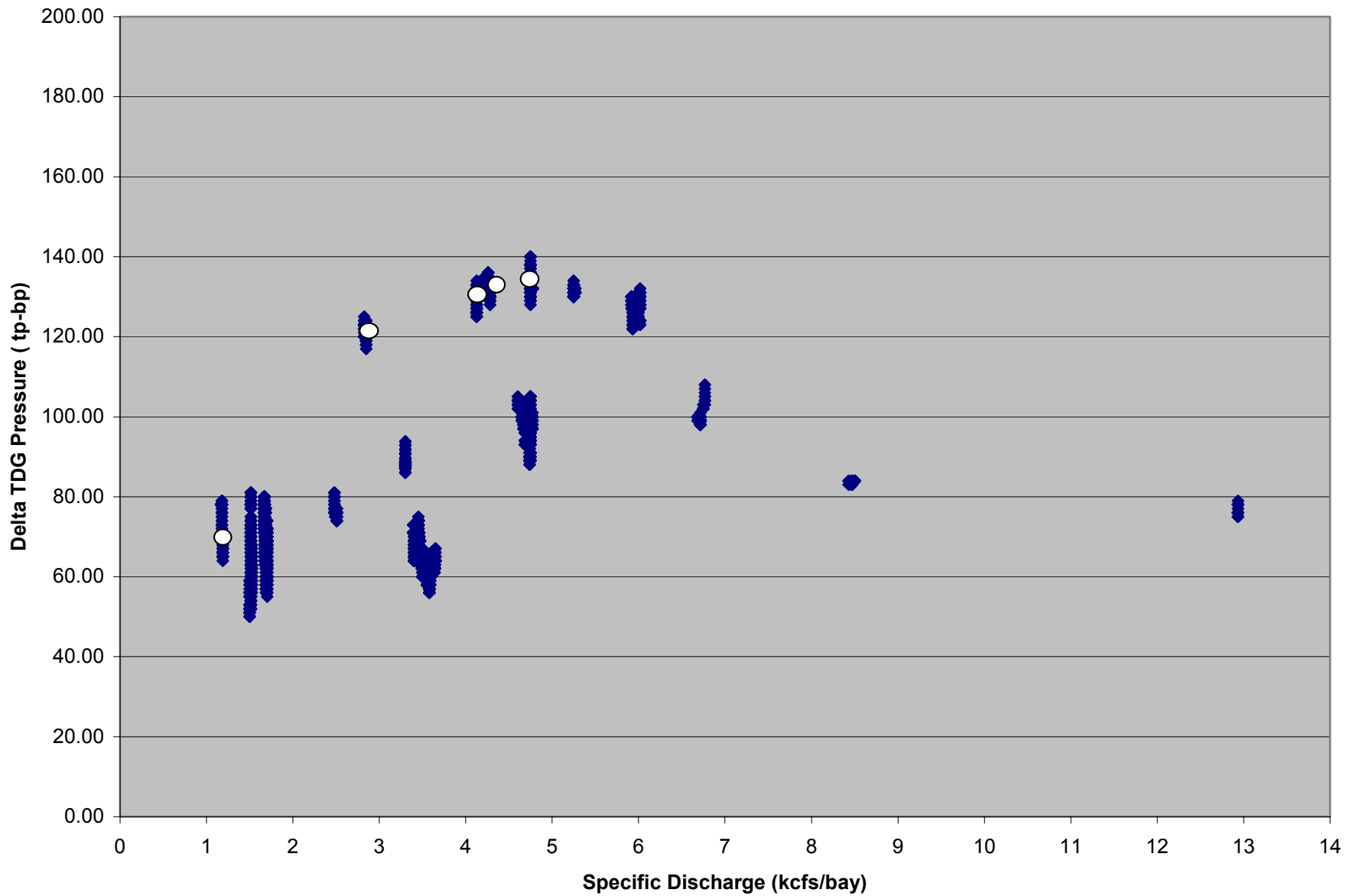


TDG saturation in the Pend Oreille River below Albeni Falls Dam,
Transect T3, Qspill=47 kcfs, Qriver=66.4 kcfs





Delta TDG pressure in spill as a function of total spill discharge at Albeni Falls Dam, 2003



Delta TDG Pressure in spill as a function of specific spillway discharge at Albeni Falls Dam, 2003

Albeni Falls TDG Exchange

- Conclusions
 - TDG Supersaturated conditions in forebay were observed
 - Upstream TDG sources
 - Priest River flows bias forebay TDG levels near right bank
 - Spill at Albeni Falls during 2003 made a small contribution to TDG loading in Pend Oreille River
 - Uniform spill pattern generally resulted in smallest impacts on TDG exchange
 - Low level of TDG exchange
 - Low head
 - Shallow tailwater flow conditions
 - Wide spillway
 - Mixing zone of PH and spillway releases extends over 3 miles downstream of project

Albeni Falls TDG Exchange

- Recommendations
 - Uniform 10 bay spill pattern
 - Locate forebay FMS away from right bank
 - Locate tailwater FMS at USGS gage
 - Evaluation of In-pool TDG exchange processes
 - Continued monitoring for TDG
 - Capture response during higher flow conditions

